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THE MESOZOIC FLORA OF PORTUGAL COMPARED WITH THAT OF THE UNITED STATES.

HISTORICAL NOTICE.

THE earliest studies in the Mesozoic deposits of Portugal seem to have been made by Mr. Daniel Sharpe, who read a paper before the Geological Society of London on April 11, 1832, describing certain beds in the vicinity of Lisbon and Oporto; in the former of which were included strata referred by him to the Oolite. On the 9th and 23d of January, 1839, he presented a second paper describing more fully the secondary formations in the vicinity of Lisbon.* On November 21, 1849, Mr. Sharpe read still a third paper before the same society† of a much more extended nature and devoted entirely to the secondary formation. In this paper is a full list of all the fossils known down to that date carefully determined by Mr. John Morris. Included in these was a single fossil plant regarded by Mr. Morris as a variety of a species of the Yorkshire Oolite called by Phillips *Cycadites gramineus*. It was found at Cape Mondego, and from this circumstance was given the varietal name *Mundæ*. As Mr. Morris referred Phillips' plant to the genus Zamites, the Portuguese plant was made to bear the name *Zamites gramineus* var. *Mundæ*.

In 1858 Sr. Charles Ribeiro published a series of elaborate papers on the Geology of Portugal,‡ treating chiefly of the Carboniferous; but in two of these§ he considers the Lias and Oolite, mentioning the plant above referred to from Cape Mondego and

* *Geol. Soc. Lond., Proc.*, Vol. I., p. 395; Vol. II., p. 31; Trans., 2d Ser., Vol. VI., p. 115ff.

† *Quart. Journ. Geol. Soc. Lond.*, Vol. VI., pp. 135–201.

‡ *Mem. Acad. Real. Sci. de Lisboa*, New Ser., Vol. II.

§ *Mina de Carvão de Pedra do Cabo Mondego, do districto de Leiria;* op. cit., Pt. II., Third and Fourth Memoirs (these memoirs are separately paged).

four other species from this and other localities.

Meantime other collections were being made, and in 1880 M. Paul Choffat published a somewhat elaborate report on the geology of the Jurassic of Portugal* in which the fossil plants were considered as far as available. The collections were sent by Choffat to Professor Oswald Heer, and a preliminary report upon them was received in time to be inserted as an Addendum. Heer's full report appeared a year later† and constitutes the first important contribution to the Mesozoic flora of Portugal. It also includes a large number of Tertiary plants. The horizons are here regarded as embracing: first, the Rhetic; second, the Jurassic, subdivided into Lias, Oolite or Dogger, and Upper Jurassic or Malm; and third, the Cretaceous, which was largely compared with the Wealden of other parts of Europe. Heer found in these collections 5 Rhetic, 18 Jurassic, and 23 Cretaceous forms. The Cretaceous plants consisted chiefly of ferns, cycads and conifers, but two of them were referred to the monocotyledons. No traces of dicotyledons were discovered.

M. Choffat continued his investigations and after Heer's death sent the plant-impressions to the Marquis Saporta at Aix; the latter was greatly interested in them and published three preliminary reports.‡ What specially attracted him was the presence of certain peculiar forms from this Lower Cretaceous horizon that he regarded as prototypes of the existing dicotyledonous flora. No dicotyledons had thus far been reported from any Lower Cretaceous deposit in Europe, and it had long been supposed that the Cenomanian was the earliest horizon at which this type existed. The several instalments embraced in these papers were from horizons in the Cretaceous, some of which were the same as those containing the plants described by Heer, while others were considerably higher. They contained a number of very remarkable forms, and the Marquis could not doubt that they represented ancestral dicotyledons. The full report upon these interesting collections has been waited for with great impatience, especially by American geologists familiar with our Potomac formation, in which the case is so nearly paralleled. In fact the present writer, having learned through correspondence with the Marquis that large collections were in his hands, and not knowing how soon his report would appear, was so desirous of learning more in regard to them that while in Europe during the past summer, by previous arrangement with him and at his urgent request, he paid a visit to the veteran paleobotanist at Aix, in the South of France, and through his extreme courtesy was not only permitted to examine these collections, but enjoyed the great favor of discussing with him a large number of the most interesting questions to which they give rise. It was then that he learned that the final report was already in press and would soon appear, and proof sheets of the text and plates were then in the possession of the author, so that it was possible to examine the work in immediate connection with the specimens. This work has now appeared* and copies of it are in the hands of American geologists; but it may

* *Étude stratigraphique et Paléontologique des terrains Jurassiques du Portugal.* Première livraison. Le Lias et le Dogger au Nord du Tage. Section des travaux géologiques du Portugal, Lisbonne, 1880.

† *Contributions à la flore fossile du Portugal par le* Dr. Oswald Heer. Section des travaux géologiques du Portugal, Lisbonne, 1881.

‡ *Comptes Rendus Acad. Sci. de Paris*, Vol. CVI., May 28, 1888, pp. 1500–1504; CXI., December 1, 1890, pp. 812–815; CXIII., August 3, 1891, pp. 249–253.

* *Flore fossile du Portugal.* Nouvelles contributions à la flore Mésozoique par le Marquis Saporta. Accompagnées d' une notice stratigraphique par Paul Choffat. (Avec 40 planches.) Direction des travaux géologiques du Portugal, Lisbonne, 1894.

as well be stated here that although a large and voluminous report containing 280 quarto pages and 39 plates, it still comes far short of covering the material that is now in the author's hands. The collections were sent to him in instalments almost every year and are still arriving, but it was necessary to fix some limit to the publication, which was closed at a certain date and the work sent to press, since which time other collections have been received, which were also carefully examined on that occasion at the Chateau of Fonscolombe, the country residence of the Marquis, 16 kilometers north of Aix, and upon which he was at the time actively engaged. These will be reported upon in a subsequent memoir. The remarkable parallelism between the plant bearing deposits of the west coast of Portugal and those of the eastern part of the United States, and especially between the Lower Cretaceous of Portugal and our Potomac formation, gives an especial interest to this memoir.

THE JURASSIC FLORA.

IN America there is a decided time hiatus between the lowest Potomac beds and the next plant bearing horizon below, which is now regarded as belonging to the extreme Upper Triassic and as about the equivalent of the Keuper deposits of Lunz, in Austria.* In Portugal, on the contrary, there appear to be no plant bearing horizons in the Trias proper, but in the Jurassic, which is absent in this country, a considerable number of such deposits have been found. M. Choffat, who prepared the geological part of this memoir, follows as closely as possible the nomenclature of the French geologists, and it is found that plant bearing horizons occur in the Infralias, part of which may be as low as the Rhetic, and some of which is referred to the Sinemurian; in the Lias; in several of the properly Oolitic beds (Toarcian, Bajocian, Callovian, etc.); in several members of the Corallian; in the Kimmeridgian, and in the Portlandian. The Jurassic deposits of Portugal consist of sandstones and limestones, the former predominating below; and while all of them may not be of marine origin, so large a part is fossiliferous that by the aid of the careful stratigraphical investigations of the Portuguese geologist it is possible to fix the position of the plant beds with relation to those holding animal remains, a fact which is of the utmost importance in determining the validity of the evidence of fossil plants in such countries as America, where, for the most part, no such guide exists.

The Jurassic flora of Portugal, as embraced in the present memoir and in that of Heer already mentioned, consists of 122 species, of which 22 are Infralias, 1 Lias, 8 Oolite, 8 Corallian and 88 Kimmeridgian. It is subdivided into 6 Algæ, 6 Equiseta, 70 ferns, 7 Cycads, 24 Conifers and 9 Monocotyledons. Of the ferns, which so largely predominate, 27 species belong to the genus Sphenopteris, 8 to Cladophlebis, 8 to Scleropteris, and 4 each to Pecopteris and Hymenophyllites. Of the conifers, which come next in importance, 5 belong to Pagiophyllum, 4 to Brachyphyllum, and 3 to Thuyites. The cycads belong to the two genera Podozamites and Otozamites. Seven of the Monocotyledons consist of small blades and culms of grasses, grouped under the genus Poacites.

A comparison of this Jurassic flora with that of the American Trias reveals the fact that while only 3 species, *Cheirolepis Münsteri*, *Pagiophyllum peregrinum* and *Palissya Brownii*, are common to the two, there are 14 genera that occur in both. In the number of species the two floras as now known are almost equal, that of the American Trias numbering 119, while that of the Portuguese Jurassic numbers 122. It is there-

*See *Bull. Geol. Soc. Am.*, Vol. III, 1891, p. 31.

fore important to note in what proportions these 14 genera occur in the two floras:

GENERA COMMON TO AMERICAN TRIAS AND JURASSIC OF PORTUGAL.

GENERA.	NUMBER OF SPECIES.	
	AMERICAN TRIAS.	JURASSIC OF PORTUGAL.
Baiera	3	1
Brachyphyllum	1 ?	5
Cheirolepis	2	1
Chondrites	3	1
Cladophlebis	7	8
Clathropteris	2	1
Equisetum	6	5
Otozamites	4	3
Pagiophyllum	6	5
Palissya	3	2
Pecopteris	1	4
Podozamites	2	3
Schizoneura	5	1
Voltzia	1	2

When we consider that the two horizons do not at all overlap and that more than three-fourths of the Portuguese plants come from the uppermost members of the Jurassic, it is not to be expected that the correspondence will be very close; and accordingly we not only miss in the Portuguese flora some of the largest American genera, such as Acrostichites, Ctenophyllum, and Pterophyllum, but also some of the most striking and abundant forms, such as Macrotæniopteris, while on the other hand no monocotyledons occur in the American Trias so far as known, and the two largest genera of ferns in the Portuguese Jurassic, Sphenopteris and Scleropteris, are entirely wanting in the American Trias.

THE CRETACEOUS FLORA.

The Cretaceous flora of Portugal has much greater interest for the student of American paleobotany than the Jurassic flora, which has just been considered. First, because, as now known, it is considerably larger, numbering 199 species, but chiefly because we have in America a large number of plant bearing deposits that correspond so closely with those of Portugal that a comparison may be legitimately made that furnishes valuable results. It is true that our American Lower Cretaceous flora has now been so extensively worked that it has assumed relatively large proportions, numbering, so far as known, over 800 species. The Potomac formation alone furnishes no less than 737. The interest is still further heightened by the fact that in the Lower Cretaceous of both Portugal and America, the plant bearing beds occur at a number of distinct horizons, which may not without profit be directly compared in the two countries. For example, the Potomac formation now furnishes at least five distinct horizons from which fossil plants have been obtained, the lowest being that of the James River, which may extend as low as the top of the Jurassic. The next higher is that so well known at Fredericksburg, Virginia, and other points on the Rappahannock and Potomac Rivers. The third is the Mount Vernon clays which directly overlie the last named and have furnished a distinct flora. The fourth is well developed in the vicinity of Aquia Creek, the plant bearing beds near Brooke, Virginia. The fifth is undoubtedly much higher, and there appears to be a considerable thickness of non-fossiliferous deposits intervening between the last named and those plant bearing beds that have been discovered on the eastern side of the District of Columbia and at other points near Washington, on the Severn River, and on the Eastern Shore of the Chesapeake Bay, which have furnished a flora substantially identical with that of the Amboy clays on the Raritan River and of Staten Island, Long Island and Marthas Vineyard, as well as of the Tuscaloosa formation of Alabama.

The Lower Cretaceous of Portugal is subdivided into a very similar series of plant bearing deposits. One locality, Valle-de-Brouco, is referred by Choffat to the Infravalanginian, which is at the very base of the Neocomian and corresponds well with

our James River series. An important plant bearing locality between Matta and Valle-de-Lobos is regarded as Valanginian or Neocomian. It may be compared with the Fredericksburg beds of the Potomac formation. The beds of Almargem, which have furnished many species, overlie the recognized Urgonian and probably belong to the upper portion of that subdivision, or possibly to the base of the next one called by the French geologists the Aptian. It corresponds quite closely with the Kome beds of Greenland and may be compared with the Mount Vernon clays of the Potomac formation, though it is probably higher. Then there is a series of beds in the vicinity of Torres-Vedras, viz., at S. Sebastião, Quinta-da-Fonte-Nova, Forca, Quinta-do-Chafariz, Portella-da-Villa, etc., and another series in the vicinity of Cercal and Zambujeiro, which are classed as Aptian, between which and the last named there is a considerable interval, including marine deposits belonging to the Urgonian. Certain other beds, as at Caixaria and Caranguejeira, are less definitely fixed geologically, but probably belong to about the same horizon. The Aptian of the French geologists lies between the Urgonian below and the Albian above, and corresponds in the main with the lower Greensand of England. It may be compared with those deposits of the Potomac formation near Aquia Creek called the Brooke beds by Professor Fontaine, which have yielded a large number of fossil plants, including such well-marked dicotyledons as Celastrophyllum and Sapindophyllum.

Above these beds there is an abundant plant locality at Buarcos, which is classed as Albian, and still higher others at Nazareth, Alcanede and Monsanto, also regarded as Albian, but as belonging to that uppermost member called Vraconnian. The Albian corresponds in a general way with the Gault and is the uppermost section of the Lower Cretaceous, the overlying beds being Cenomanian, which is the lowest subdivision of the Upper Cretaceous. These Albian plant bearing beds may be roughly compared with what has been called in America the Amboy clays, but which has recently been more correctly named by Professor William B. Clark the Raritan formation. In America, as in Portugal, this deposit may also be divided into two parts, a lower and an upper, the former consisting of the beds along the Raritan, which themselves have a considerable thickness and show marked changes in the flora, while to the latter belong the deposits on Staten Island, Long Island and Martha's Vineyard, which have yielded large collections chiefly from indurated nodules formed in red clay.

Finally, in the Valley of Alcantara, at Padro, Pombal and Villa-Verde-de-Tentugal, there are plant bearing beds belonging to the Cenomanian. It is possible that these latter may not be higher than those of Long Island and Gay Head.

The floras of the several horizons in the Lower Cretaceous of Portugal differ less in their abundance than those of the Jurassic; the largest is that of the Valanginian, amounting to 86 species or over 43 per cent.; the Urgonian has yielded only 25 species or 12 per cent., the Aptian 42 species or a little more than 21 per cent., the Lower Albian 58 species or over 25 per cent., and the Upper Albian or Vraconnian 28 species or 14 per cent. The striking coincidence of the parallelism between these horizons and those of the Potomac formation in America is still further heightened by the circumstance, accidental perhaps, that the numerical proportion existing between the species now known at the corresponding horizons in America is very nearly the same. The Basal Potomac, corresponding to the Vraconnian, has yielded 329 species or a little over 44 per cent.; the Mount Vernon clays, which were compared with the Urgonian, 42 species

or somewhat less than 6 per cent.; the Aquia Creek beds, corresponding to the Aptian, 137 species or rather more than 18 per cent.; the Raritan beds and their equivalents, compared to the lower Albian, 264 species or nearly 36 per cent.; and the uppermost beds of Marthas Vineyard, Long Island and Staten Island, which may be called the Island Series and compared to the Vraconnian, 133 species or 18 per cent. These results may be put in the following tabular form:

LOWER CRETACEOUS OF PORTUGAL.		POTOMAC FORMATION OF THE UNITED STATES.	
HORIZONS.	PER CENT.	HORIZONS.	PER CENT.
Vraconnian . . .	14	Island series . . .	18
Lower Albian . .	29	Amboy Clays, etc. .	36
Aptian	21	Aquia Creek (Brooke) Series .	18
Urgonian	12	Mt. Vernon Clays .	6
Neocomian	43	James and Rappahannock Series .	44

It will be remembered that the Mount Vernon clays have been very little developed as yet, and when this florula is thoroughly known it will probably fully equal that of the Almargem beds of Portugal, relatively to the total Potomac flora.

Taking the Cretaceous flora of Portugal as a whole, exclusive of the Cenomanian, it is found to consist of 4 algæ, 1 species of Isoetes, 3 of Lycopodites, 1 of Equisetum, 80 of ferns, 15 of cycads, 26 of conifers, 4 of anomalous types, classed by the author under the head of Proangiosperms, 18 of monocotyledons, 41 of dicotyledons, and 6 of forms of uncertain affinity.

It will be seen that as in the Jurassic, so in the Cretaceous the ferns predominate; and of these, 32 species belong to the genus Sphenopteris and 10 to Cladophlebis; 7 of the cycads belong to the genus Podozamites, and 3 to Glossozamites. The conifers are much more evenly distributed, there being 4 species of Brachyphyllum, and 3 each of Sphenolepidium and Thuyites, while a large number of genera have only one or two species; among these are Abietites, Baiera, Cheirolepis, Frenelopsis, Pagiophyllum, Palæocyparis, Palæolepis, Sequoia and Widdringtonites. The genera referred to the Proangiosperms are Changarniera, Eolirion, Yuccites, Delgadopsis and Protorhipis, some of which will require special mention further on. Half of the monocotyledons consist of grass-like objects referred to poacites, some of which he classes under the Proangiosperms, and others as true monocotyledons. The dicotyledonous flora is here well developed, but most of the forms occur in the Albian. Seven species are referred to a new genus, Proteophyllum, a name too near Protophyllum of Lesquereux, and Proteæphyllum of Fontaine, but the forms are different from both these; 4 to the new genus Dicotylophyllum, and 3 each to Eucalyptus and Salix.

In comparing the Cretaceous flora of Portugal with that of America it is true that we only find a few species that are common to the two countries, really only five, as follows:

Pecopteris Brauniana Dunk.

Sphenolepidium Kurrianum (Dunk.) Heer.

Sphenolepidium Sternbergianum (Dunk.) Heer.

Sphenopteris Mantelli Brongn.

Sphenopteris valdensis Heer,

the last of which only occurs doubtfully in the Trinity of Texas.

Add to these *Sequoir subulata*, of which a very near variety *lusitanica*, has been found in the Portuguese beds.

We should not, of course, expect the species to be common to any great extent, and the comparison is practically limited to the genera. Looked at from this point of view, we see that the resemblance is indeed close, a great number of the important genera occurring in both floras. There are no less than 46 of these common to the two,

though in some cases the author's individuality is probably alone responsible for slight differences of termination in the names. For example, forms referred to Baiera by one would be referred to Baieriopsis by the other, and so with Ctenis and Ctenidium, Myrsine and Myrsinophyllum, Oleandra and Oleandridium, Salix and Saliciphyllum, Thuya and Thuyites, etc.

Many of these genera, when we consider the difference in the size of the two floras, occur in both countries in nearly the same proportion. For example, of Aralia we have in Portugal 2 species, in America 11; of Brachyphyllum, in Portugal 4, in America 9; of Cladophlebis, in Portugal 10, in America 25; of Frenelopsis, in Portugal 2, in America 6; of Laurus, in Portugal 2, in America 8; of Myrica, in Portugal 2, in America 11; of Podozamites, in Portugal 7, in America 15; of Sphenolepidium, in Portugal 3, in America 9, etc. There are, of course, some cases in which the proportion is not the same. Thus, only one species of Magnolia occurs in the Portuguese beds, while in America we have 12, and on the other hand the largest Portuguese genus, Sphenopteris, represented there by 32 species, counts in America only 8 species. But here it may be supposed that the true representative in America of the Sphenopteris type of Portugal is really that exceedingly abundant genus Thyrsopteris, which numbers 40 species in the American beds. This would restore the relative proportions. On the whole, then, it may be considered that the Lower Cretaceous flora of Portugal is botanically speaking a very close repetition of that of America; and in view of the fact that in both countries a number of distinct horizons showing the progressive change in the flora throughout that period have yielded fossil plants in such a way that each of these florules may also be compared, the interest in the subject is almost fascinating.

ARCHETYPAL ANGIOSPERMS.

SPACE will only permit the consideration of one other important aspect, viz., a comparison of the dicotyledonous forms in the two countries, together with those ancestral types which the Marquis Saporta regards as prophetic of that great group of plants. This last question may be considered first. He finds among the specimens certain forms which he refers to the genus Protorhipis of Andræ. This genus was founded in 1855 upon some remarkable forms from the Lias of Steierdorf in Banat, Hungary,* which Andræ regarded as a fern and placed under the Pecopterideæ. He compares it with Jeanpaulia, which has since been proved identical with Baiera and correctly referred to the Coniferæ; also to Cyclopteris, Comptopteris, Diplodictyum, and Thaumatopteris, among fossils, and to Platycerium, among living ferns.

When I first saw the figure of his *Protorhipis Buchii*, I had grave doubts of its being a fern and fully believed that it represented some higher type of vegetation. I am, therefore, not surprised that the Marquis Saporta has arrived at the same conclusion, and am highly gratified that he has had the courage to give it publicity, notwithstanding the fact that Schimper, Schenk, Heer and Nathorst have all been content to regard it as a fern of the type of Drynaria, Platycerium, Allosorus, Clathropteris and the other living and fossil forms already mentioned.

In 1865 Zigno discovered another species, which, however, differs in a marked manner from the original of Andræ, having the margin entire. It is a small, deeply kidney-shaped leaf resembling that of some species of Asarum and was named *P. asarifolia.* This comes from the Oolite of Italy.†

*Lias-Flora von Steierdorf im Banate, by C. J. Andræ, Abhandl. geol. Reichsanst., Vol. II., Abth. 3, No. 4, 1855, pp. 35–36, pl. viii., fig. 1.

†Fl. Foss. Form. Oolithicæ, Vol. I, 1865, p. 180, pl. ix., fig. 2, 2a.

The forms described by Nathorst in 1878,* though much smaller are otherwise similar to *P. Buchii*, and Nathorst at first proposed to refer one of them to that species, but later concluded that it was distinct and made two species, *P. integrifolia* and *P. crenata.*

In 1880 Heer described another small cordate form from the Oolite of Siberia. It is similar to Zigno's species and was named *P. reniformis.*† Two years later, however, he found another similar form in the Kome beds, Urgonian, which is rather cordate than reniform and which he called *P. cordata.*‡ Both these forms have the margin entire.

Saporta in this work has revised all these forms and comes to the conclusion that they cannot be ferns, and although the original *P. Buchii* and both of Nathorst's species so closely resemble dicotyledonous leaves and are somewhat comparable in nervation to Credneria and some fossil Viburnums, as well as to such living genera as Glechoma and Chrysosplenium, still he hesitates to class them in that group. He has carefully refigured both of Nathorst's specimens, and also one that Nathorst figured without naming but regarded as probably a monocotyledon, but which Saporata considers to belong to the same type and calls *P. Nathorstii.* And these he carefully compares with the Portuguese form which he names *P. Choffati*, and classes the whole in special group which he long ago created and denominated the Proangiosperms, as representing the forerunners of both the monocotyledons and dicotyledons. The Portuguese species comes from Cercal, which Choffat places in the Aptian; it is therefore probably somewhat higher than the Kome beds of Greenland from which Heer derives one of his species; all the others, of course, are of far more ancient origin, viz., Jurassic, and it is not to be wondered at that no one should have ventured to refer them to any modern type.

Of the other four genera referred to this group, viz., Changarniera, Yuccites, Delgadopsis and Eolirion, the first two come from the Valanginian (Neocomian) of S. Sebatião, the third from the Aptian of Cercal, and the last from the Albian of Buarcos. They all seem to be ancestral monocotyledons. Delgadopsis occurs in two forms: first, as a sort of culm or broad striate stem; and secondly, in the form of a jointed rhizome, the swollen joints emitting innumerable rootlets, which, when absent, leave peculiar scars.

Choffatia Francheti, regarded by the author as a dicotyledon, is also a very remarkable plant, and has been aptly compared by him to certain euphorbiaceous forms, such as Phyllanthus. It also resembles some species of Euphorbia. It seems to be a floating aquatic, and specimens with the fibrous roots occur in the collection. In some of these descending fibers occupy one side of the stem or rachis, while the floating or aerial leaves occupy the other.

Upon the whole, it cannot be said that any of these higher types, found below the Albian, and corresponding in age to our middle and older Potomac, very closely resemble the plants of the same general class from the American beds of that age, and yet there are certain Potomac forms referred by Professor Fontaine to Menispermites, Hederæphyllum, Proteæphyllum and Populophyllum, whose areolate nervation somewhat resembles that of *Protorhipis Choffati.* The new genus Dicotylophyllum, of which he finds four species in the Aptian of Cercal, and which he very properly regards as a true dicotyledon, somewhat resembles the Protorhipis, but lacks the peculiar areolate

*Fl. Bjuf. Heft 1, p. 42; Heft 2, p. 57, pl. ix., figs. 2, 4.

†Fl. Foss. Arct., Vol. VI., Abth. 1, Pt. 1, p. 8, pl. 1, fig. 4a.

‡Ibid., Abth. 2, p. 11, pl. iii, fig. 11.

nervation. These leaves are all quite small, but show a somewhat distinct midrib, and usually 2–4 lateral primaries. In form they recall some species of Vitis or Cissities, and *D. cerciforme*, while not resembling Cercis, as the specific name would imply, has many of the characteristics of Hedera. It may be roughly compared with Professor Fontaine's Vitiphyllum from the Potomac of Baltimore, and except in size *D. hederaceum* and *D. corrugatum* are fairly comparable with *Populophyllum reniforme* (cf. Fl. Pot., pl. clvi., f. 3).

In the Albian beds of Buarcos, and especially in the Vraconnian of Nazareth, we begin to find some of the higher types. But the genus Proteophyllum has still a very ancient appearance with a more or less areolate nervation. It is a narrowly lobed leaf, remotely recalling in its general form some species of Dewalquea. It may be possible to trace this form into his *Aralia calomorpha* from the same beds. His *Adoxa præatavia* is a very peculiar plant, which also reminds one of Vitiphyllum Font., although none of the species of the latter genus which show the branching character have yet been figured. His *Braseniopsis venulosa* has some of the characteristics of Protophyllum of Lesquereux, but is usually smaller and always entire; the nervation is also different, except at the base of the leaf, which has a large expansion below the summit of the petiole, as in Protophyllum. *Myrsinophyllum revisendum* will doubtles have to be revised. It is much like Potomac forms that have been referred to Myrica (e. g., *M. brookensis*) and Celastrophyllum. It is entirely different from the *Myrsine borealis* of Heer, which, with two other species, occur in the Amboy clays and Tuscaloosa formation. His *Geranium lucidum* is an exceedingly definite and handsome form, but it is hard to separate it generically from his *Cissites sinuosus*, and all of these seem to be analogous to our Vitiphyllum. His *Menispermites cercidifolius*, though much smaller, is not unlike Professor Fontaine's *M. Virginiensis*, especially the smaller forms which I have found in the Mt. Vernon clays. His *Aralia proxima* can scarcely be distinguished from *M. Wellingtoniana* of the Dakota group, more common in the Newer Potomac.

It is only in the Nazareth beds (Vraconnian) that we find the typical Amboy Clay flora. Here we have the Eucalyptus, Laurus (Laurophyllum), Salix, Myrsinophyllum, Sapindophyllum, etc., some of which are probably specifically identical with forms described by Newberry, and it is altogether probable that if the posthumous work of Dr. Newberry, now in press, had been in the hands of the present author a large number of the species would have been identified with American forms.

I will only notice one other significant fact. In the Cenomanian beds which overlie these last, as it would seem unconformably, but which may not be so widely separated from them as has been supposed, there occurs a large elongated leaf which the Marquis has called *Chondrophyton laceratum*. It agrees only in its finer nervation with *C. dissectum* Sap. and Mar., the only other species.* It has a very delicate nervation with small polygonal meshes, and an entire paryphodrome margin, but the remarkable fact is that it seems to have a deeply retuse summit. It is evident that from the specimen the author was unable to make this latter out with certainty; but he has drawn the marginal lines so as distinctly to indicate it. So desirous was he that this leaf should be correctly represented that he has given us two interpretations from drawings made at different times, figs. 4, 5 of pl. xxxviii. He states that he considers figure 5 to represent the form better than figure 4; and it is in this

*L. Évolution du Règne Végétal. Par Saporta et Marion. Les Phanérogames, Vol. II., Paris, 1885, p. 120, fig. 126.

that the terminal lobation is most clearly shown. A comparison of this figure with the numerous specimens of *Liriodendropsis simplex* of Newberry leaves no doubt whatever that the Portuguese plant is at least a congener of the American plant, and it is just possible that it may belong to the same species. As this form has been three times published* it is a little surprising that Saporta did not think to compare it with the Portuguese plant. There are differences in the finer nervation, but this is also perceptible between his two drawings of the same specimen; these also differ in different specimens of the American plant, and one or two other species remain to be published. When all the material is illustrated most of these differences will disappear. If any remain it can be ascribed to difference of age and geographical position.

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Washington.

EXPLANATION OF ACQUIRED IMMUNITY FROM INFECTIOUS DISEASES.†

It has long been known that, in a considerable number of infectious diseases, a single attack, however mild, affords protection against subsequent attacks of the same disease; that in some cases this protection appears to be permanent, lasting during the life of the individual; that in others it is more or less temporary, as shown by the occurrence of a subsequent attack.

The protection afforded by a single attack not only differs in different diseases, but in the same disease varies greatly in different individuals. Thus certain individuals have been known to suffer several attacks of small-pox or of scarlet fever, although, as a rule, a single attack is protective. Exceptional susceptibility or insusceptibility may be not only an individual but a family characteristic, or it may belong to a particular race.

In those diseases in which second attacks are not infrequent, as, for example, in pneumonia, in influenza or in Asiatic cholera, it is difficult to judge from clinical experience whether a first attack exerts any protective influence. But from experiments upon the lower animals, we are led to believe that a certain degree of immunity, lasting for a longer or shorter time, is afforded by an attack of pneumonia or of cholera, and probably of all infections due to bacterial parasites. In the malarial fevers, which are due to a parasite of a different class, one attack affords no protection, but rather predisposes to a subsequent attack.

In those diseases in which a single attack is generally recognized as being protective, exceptional cases occur in which subsequent attacks are developed as a result of unusual susceptibility or exposure under circumstances especially favorable to infection. Maiselis has recently (1894) gone through the literature accessible to him for the purpose of determining the frequency with which second attacks occur in the various diseases below mentioned. The result is as follows:

	Second Attacks.	Third Attacks.	Fourth Attacks.	Total.
Small-pox . .	505	9	0	514
Scarlet fever .	29	4	0	33
Measles . . .	36	1	0	37
Typhoid fever .	202	5	1	208
Cholera . . .	29	3	2	34

Recent researches indicate that the principal factor in the production of acquired immunity is the presence, in the blood of the immune animal, of some substance capable of neutralizing the toxic products of the particular pathogenic microörganism

* Bull. Torr. Bot. Club, Vol. XIV., New York, Jan. 1887, p. 6, pl. lxii, figs. 2, 3, 4; Am. Journ. Sci., Vol. XXXIX., New Haven, February, 1890, p. 98, pl. ii., figs. 6, 7; Trans. N. Y. Acad, Sci., Vol. XI., 1892, p. 102, pl. ii., figs. 2–7, 9.

† Abstract of a paper read before the Biological Society of Washington, March 9, 1895.